

Claims 1-18 were presented for examination. Claim 1 has been amended. Claims 11-18 have been canceled. Reconsideration is respectfully requested.

Claims 1-18 are rejected under 35 USC 112, first paragraph, as containing subject matter not described in the specification in a way to convey possession of the claimed invention. This rejection is respectfully traversed.

The Examiner states that there is no support or disclosure for making the claimed derivatives. Claim 1 has been amended to delete the derivatives and Claims 11-18 have been canceled, without prejudice to filing a continuation or CIP application thereon.

The Examiner states that 400 torr He is an important factor in C36 production and should be incorporated into Claim 6.

As stated previously, this limitation is a specific detail of one particular embodiment of making C36 and is contained in dependent Claim 7. Claim 6 is a more generic claim to making C36 rich arc soot and separating the C36. The general methods of making graphite arc soot are known, and in light of Applicant's disclosure, one skilled in the art can adjust process parameters such as pressure to enhance C36 production.

As described on page 5, "Bulk quantities of C36 are produced by a modified Kratschmer-Huffman arc plasma technique. The technique has been modified to enhance the production of C36." As stated, under normal conditions, higher order fullerenes are produced with very little, if any lower order fullerenes. But, "as part of the invention, it has been determined that under certain conditions, C36 can be produced in relatively large amounts, e.g. 1-2% of the carbon soot." Thus one skilled in the art is lead to vary the process conditions from the normal conditions to increase C36 production.

Page 5 continues: "Optimum parameters for C36 production were determined in a helium environment arc discharge chamber originally designed for C60 production." Several specific parameters of this chamber then follow. This clearly is an illustrative example of one particular chamber, not the only chamber in which C36 could be made. For example arc discharge chambers could use another inert gas than He.

Page 6 states: "The synthesis of C36 is very sensitive to operational parameters, notably helium pressure." Tests from 50-1500 torr He are then described, with 400 torr being optimum. These tests are clearly on the chamber described on page 5. One skilled in the art would not expect all chambers to operate at the same parameters. The broader statement on page 6 clearly leads one skilled in the art to vary the operational parameters of any particular apparatus to find the optimum for C36 production.

The Examiner's characterization of Applicant's argument as "C36 can be made using a well-known modification of a standard fullerene (C60) process" is erroneous. Applicant has argued that C36 can be made by a modification, as taught by Applicant and not already well-known, to a well-known standard C60 process. Thus it is the standard process that is well-known, not Applicant's modification thereto to increase C36. Therefore the conclusion that Applicant appears to admit that the present process is obvious over the known prior art is baseless.

Furthermore, even if the step of producing a C36 rich soot were known, the claimed process includes additional steps for first removing higher order fullerenes, then removing C36, and finally forming a solid from the C36. The Examiner has not shown any of these steps in the prior art.

The Examiner states that Claim 6 does not recite performing an arc process.

Claim 6 recites "producing ... arc soot." This is one way of reciting the step. How else is "arc soot" produced except in an arc?

Therefore it is submitted that the rejection is obviated.

Claims 15-16 are rejected under 35 USC 112, second paragraph as indefinite.

This rejection is moot since the claims have been canceled.

Claims 1-5, 10 are rejected under 35 USC 102(b) or 103(a) over Stankevich. The Examiner states that Stankevich teaches C36 on p. 172 and that "As its properties are reported, it appears to have been made and isolated." This rejection is respectfully traversed.

As stated in the prior response, the Examiner's characterization of Stankevich is clearly erroneous. The paper is a purely theoretical paper, with no measured properties reported, and no evidence that C36 was made or isolated. The Examiner is requested to show any part of the paper where any experimental work leading to Table I is described. There is not a scintilla of evidence of experimentation since none was done.

The Abstract states that carbon cluster structures were studied by "topological and valence approaches" which are well-known theoretical methods as clearly shown on p. 170-171. The topological method description on p. 170 is purely mathematical, i.e. "the secular equation ... is subdivided into six equations" and "Calculation ... is reduced to the eigenvalue problem for the six complex matrix Hamiltonians." Likewise the description on p. 171 of the valence method is purely mathematical, i.e. "... have been calculated by the MNDO/PM3 method." The first three lines of p. 169 state that cited work "stimulates further modeling of various carbon cluster structures and prognosis of

their properties." Thus the values given in Table 1 on p. 172 are purely theoretical calculations, i.e. the prognosis from the theoretical models.

The Examiner's statement that Stankevitch is no more "theoretical" than Applicant's disclosure and also contains "hard" data supporting actual experimentation is erroneous and baseless. Applicant has shown real experimental results, e.g. the mass spectra of Figs. 1, 3 and the NMR spectra of Fig. 5B. Applicant has also described the apparatus (Figs. 2, 4) and tests involving different He pressures in a particular chamber to determine optimum pressure for that chamber. Stankevitch has no experimental data whatsoever since all values were calculated from theoretical models.

There is also no suggestion of forming coatings as in Claim 5. Claim 10 is directed to the film or powder form of the C36 material which is also not suggested. Therefore the rejection is obviated.

It is noted that Claims 6-9 are not rejected on art.

Accordingly it is submitted that all claims now pending in the case are in condition for allowance which is earnestly solicited. If any impediment should remain which can be resolved by telephone, please call Applicant's Attorney at (510) 486-4534. The Examiner is requested to enter this amendment, if not for allowance, at least for purposes of appeal, since it reduces the issues on appeal.

Respectfully submitted,

  
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## APPENDIX

Version with markings to show changes.

IN THE SPECIFICATION:

Page 5, lines 1-3, the paragraphs are amended as follows:

Figs. 8B-D show side views of relaxed crystal [structures] structures formed by stacking S2 layers according to AA, AB, or ABC sequences respectively.

Fig. [9a] 9A shows a C<sub>24</sub>N<sub>12</sub> fullerene molecule.

Page 6, lines 4-9, the paragraph is amended as follows:

The synthesis of C<sub>36</sub> is very sensitive to operational parameters, notably helium pressure. A series of experimental runs was carried out [a] at different fixed static helium pressures between 50 and 1500 torr. Runs in the series at pressures significantly different from 400 torr failed to produce prominent peaks below 720 amu in the mass spectrum. To produce bulk amounts of C<sub>36</sub> suitable for purification, arcing runs in 400 torr helium were repeated and the resulting soot was collected from the chamber walls.

Page 8, lines 13-19, the paragraph is amended as follows:

An extractor 50 to extract fullerenes from graphite arc soot under inert conditions is shown in Fig. [3] 4. Extractor 50 has a main tube 52 and a side tube 54 connected between the top and bottom of the main tube 52. The major modification in the extractor 50 is the inclusion of high vacuum Teflon stopcocks 56, 58 at the bottom and in the side tube. Water jacket 60 also surrounds main tube 52, reducing its length. A coarse frit 62

is placed across the main tube 52. The top of the extractor 50 is a female fitting 64 and the bottom is a male fitting 66.

Page 8, line 21 to page 9, line 4, the paragraph is amended as follows:

The purified solid C<sub>36</sub> material obtained was characterized using C-13 NMR, bulk electron diffraction, mid-infrared transmission, and solid state transport studies. For a 36 atom carbon cage with hexagonal and pentagonal faces, 15 different isomeric structures are theoretically possible. Calculations indicate that the lowest energy isomers are structures with D<sub>6h</sub> and D<sub>2d</sub> symmetry. These two molecules can be distinguished by NMR spectroscopy. Mass spectrometry using a laser desorption/time of flight mass spectrometer shows that the material is C<sub>36</sub>, as shown in Fig. [2] 3.

Page 10, lines 10-21, the paragraph is amended as follows:

The hexagonal and rhombohedral crystal symmetries [is] are shown in Figs. 7A-D. Each is formed by stacking hexagonally symmetric planes of well separated C<sub>36</sub> units. Figs. 7A-D show two kinds of stacking sequences, AB and ABC, corresponding to the hexagonal and rhombohedral crystals respectively. Figs. 7A, B respectively show a top view of the repeating planes and a side view showing the relaxed interlayer bonding for the AB stacking sequence. Figs. 7C, D respectively show a top view of the repeating planes and a side view showing the relaxed interlayer bonding for the ABC stacking sequence. The fundamental stacking unit is a plane of unbonded C<sub>36</sub> molecules referred to as sheet 1 (S1) and the two crystals are labelled S1-AB and S1-BC for the two kinds of stacking. The C<sub>36</sub> units are essentially noninteracting within an S1 sheet. (The AA

stacking sequence (S1-AA) is not considered because it does not form a metastable structure.)

Page 11, lines 6-10, the paragraph is amended as follows:

For S2-AA there is bonding between all six [carbon] carbon atoms of the hexagon rings on top and bottom, as in the case of S1-AB. Stacking S2 sheets in the AB sequence results in a slightly larger density and a substantially larger binding energy than S2-AA. It is the lowest energy crystal structure. The S2-ABC contains no interlayer bonding and is not likely to be stable.

Page 12, lines 13-20, the paragraph is amended as follows:

The invention also includes endohedrally doped fullerenes and intercalated solids. An atom M may be placed in the center of a C<sub>36</sub> molecule (M @ C<sub>36</sub>). Binding energy calculations show that endohedral doping of C<sub>36</sub> with alkali earth atoms Mg, Ca, and Sr, and also with Si, Ge, and Zr, is possible. The C<sub>36</sub> fullerene appears to be the smallest size [carbon cage] carbon cage which can easily trap additional atoms. As far as [intercalation] intercalation into the solid material, the S2-AB crystal structure has two cavities per C<sub>36</sub> which can be doped with other atoms, e.g. Na or K. However, [because] because of the ionic radii, Na appears to fit well but K causes structural changes.

## IN THE CLAIMS:

Claim 1 is amended as follows:

1. (Twice Amended) A composition of matter comprising a solid state material consisting essentially of C<sub>36</sub> fullerene molecules [or C<sub>36</sub> fullerene based molecules].

Delete Claims 11-18.